

THESIS

THE USE OF DEVELOPMENTAL SPEECH AND LANGUAGE TRAINING THROUGH  
MUSIC TO ENHANCE QUICK INCIDENTAL LEARNING IN CHILDREN WITH AUTISM  
SPECTRUM DISORDERS

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## ABSTRACT

### THE USE OF DEVELOPMENTAL SPEECH AND LANGUAGE TRAINING THROUGH MUSIC TO ENHANCE QUICK INCIDENTAL LEARNING IN CHILDREN WITH AUTISM SPECTRUM DISORDERS

Given vocabulary acquisition in individuals with Autism Spectrum Disorder (ASD) is an important concern, it is necessary to investigate potential treatments that enhance children's ability to learn novel words in the Quick Incidental Learning (QUIL) context. The present study examined the effects of Developmental Speech and Language Training through Music (DSLTM) to facilitate QUIL and attention in 8 children, ages 3-5, with a diagnosis of ASD. Participants were randomly assigned to one of two conditions and were exposed to speech and song scripts via a two period crossover design. An experimental session presented one song and spoken script, each embedded with 4 novel lexical items, through video stimuli. Attention was examined by recording eye gaze toward a computer monitor, and lexical probing was administered after each experimental session to measure production, comprehension, and generalization of target lexical items. The results showed that attention, production, comprehension, and generalization improved as a result of both the speech and music conditions; however, the difference between music and speech was not statistically significant.

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## CHAPTER ONE

### Introduction

#### *Statement of the Problem*

Autism Spectrum Disorder (ASD) is a neurological disorder that is behaviorally defined, as no specific biological indicator has been recognized (American Psychiatric Association [DSM-IV-TR], 2000; Pennington, 2009). ASD is characterized by marked impairments in three of the following areas: socialization, communication, and varying behaviors and interests. Specifically looking at socialization, individuals with autism often have a general lack of interest in others, difficulty orienting to and engaging others in the social environment, and often have an underdeveloped theory of mind (Gleason, 2005; Tager-Flusberg, 1999). Considering behaviors and interests, individuals with autism exhibit an array of behaviors, including persistent rituals, stereotyped motor movements, and an obsession with limited interests (American Psychiatric Association, 2000). Difficulties in communication range from no use of spoken language to difficulty in having conversation (Pennington, 2009). Furthermore, a child's use of language correlates with future development, as some estimate that half of individuals with autism are unable to develop the use of expressive language (Bailey, Phillips, & Rutter, 1996 as cited in Gleason 2005). Thus, it is crucial to identify effective strategies for the remediation of speech and language development.

#### *Speech and Language Development in Children with ASD*

Typically-developing children use various strategies to build vocabulary throughout their young life. Initial strategies are inefficient and tedious, as word learning is dependent on context and exposure to a new word. However, as children age, growing cognitive and social skills correlate with increased knowledge of language. Children learn that there are categories of

words, one word could refer to multiple referents, and words can be learned by following the social cues that others provide. Thus, joint attention plays a significant role in vocabulary development (Barrett, 1999; Gleason, 2005).

In ASD, impairments in multiple facets of speech and language exist. Some research indicates language impairment stems from areas of social communication, such as joint attention, symbol use, and a theory of mind (Gleason, 2005). Greater occurrences of joint attention have been shown to predict later vocabulary acquisition, as well as comprehension and production of novel words (McDuffie, Yoder, & Stone, 2005; McDuffie, Yoder, & Stone, 2006a). Given the difficulty individuals with ASD experience in exhibiting joint attention (Parish-Morris, Hennon, Hirsch-Pasek, Golinkoff, & Tager-Flusberg, 2007; Preissler & Carey, 2005), it is evident that this population has a disadvantage in the development of speech and language. Furthermore, a theory of mind and pragmatics are somewhat related, as pragmatics involves interpreting meaning of language based on the circumstances and situations in which it was presented (Barrett, 1999). Research indicates that the social and communicative deficits in individuals with ASD are defining characteristics of the diagnosis. It is also clear that the social aspect of language greatly impacts further development of speech and language in children with ASD and vice versa (Tager-Flusberg, 1999), which suggests that addressing both areas of impairment is necessary for optimal growth.

### *The Rationale for the Use of Music with ASD to Learn Speech and Language*

There is a growing body of research that reveals the ability of music to engage multiple regions of the brain across both hemispheres, and that many of these regions are responsible for nonmusical functions, such as speech and language. Thus, while music and speech generate distinct activations, there is a large degree of overlap. It is thought that pitch and melodic

aspects of music are right-brain specific, whereas temporal and rhythmic aspects are left-brain specific (Patel, 2008). This overlap in activations is observed in both the perception and production of music and speech (Callan et al., 2006; Jeffries, Fritz, & Braun, 2006; Maess, Koelsch, Gunter, & Friederici 2001; Ozdemir, Norton, & Schlaug, 2006). This is especially important when examining the ASD population, as research shows that when individuals with ASD participate in semantic tasks involving perceived meaning (Harris et al., 2006), and verbal imitation of words (Wan, Demaine, Zipse, Norton, & Schlaug, 2010), there is decreased activation in Broca's area. Not only is Broca's area responsible for the oral motor coordination and planning involved in speech (Shier, Butler, & Lewis, 2004), it is also thought to contain aspects of the mirror-neuron-system, which is based on the premise that the perception and comprehension of speech and language relies greatly on the observation of oral-facial musculature as well as nonverbal gestures and movements involved in spoken language (Wan et al., 2010). Thus, there are strong implications for the use of music for the habilitation of speech and language in individuals with ASD.

The argument for the utilization of music for individuals with ASD strengthens when examining the structure and organization of music and how it is readily perceived by this population (Berger, 2002; Lim, 2009; Lim, 2010; Thaut, 2005). Furthermore, the perception of speech and music in the brain is very similar, as both are organized into categories based on pitch and rhythm (McMullen & Saffran, 2004). Another commonality of music and speech perception is thought to be linked to mirror neurons, as the presentation of a musical stimulus with no linguistic quality activates the mirror neuron system in Broca's area (Wan, Demaine, Zipse, Norton, & Schlaug, 2010). A study by Thaut (1987) illustrates that children with autism might favor music stimuli, as children with ASD preferred to listen to music over a visual stimulus for



a longer duration in comparison to typical children. Given individuals with ASD readily perceive music, and perception and production of speech and music activate shared regions of the brain, music might serve as an alternative means for the habilitation of speech and language in this population. In relation to the current study, it is thought that music will enhance children's ability to learn lexical items in comparison to speech and control conditions. Participants will exhibit increased attention towards music stimuli based on its intrinsic structure and organization, and given attention is a strong indicator for later vocabulary acquisition and production, greater acquisition of lexical items will take place in comparison to just speech stimuli.

### *Significance of the Study*

In light of the aforementioned research, it is logical to conclude that music therapy would be a beneficial treatment to facilitate speech and language in individuals with ASD. While there is a sizeable amount of literature examining music therapy treatments for social, behavioral, cognitive, and communicative outcomes (Gold, Wigram, & Elefant, 2006; Whipple, 2004), the research only provides fair evidence, as many studies do not employ large sample sizes and randomized experimental designs. Moreover, two meta-analyses conducted to examine the efficacy of music therapy in the treatment of ASD did not produce overly favorable results. In the Whipple (2004) analysis, inclusion criteria were based on the experimental design used, ease of replication, and statistical results. Gold et al. (2006) had similar inclusion criteria, accept only studies utilizing specific music therapy interventions were included. It is disconcerting that only ten (Whipple, 2004) and three (Gold et al., 2006) designs were accepted based on the aforementioned criteria. Both analyses found that subjects made greater gains in the music condition as compared with other treatments or controls, but this did not provide good evidence

for music therapy given the small selection of experiments accepted. In order to validate music therapy as an efficient treatment method, it is essential that more research studies emerge utilizing appropriate treatment designs and larger sample sizes.

While recent literature has shown that music intervention can improve socialization and various aspects of communication in children with autism, the validity of the research is questionable. For example, improvisational music therapy was shown to increase occurrences of preverbal communicative behavior such as joint attention and turn-taking, but only a small sample of children with autism were examined (Kim, Wigram, & Gold, 2008). Other music therapy interventions such as individualized song compositions also improved social and communicative behavior in the classroom settings, but these were case studies, as only one and two young children participated (Geist, McCarthy, Rodgers-Smith, & Porter 2008; Kern, Wolery, & Aldridge 2007). There is some research studying music and facilitation of speech in ASD that has incorporated positive changes and thus, greater validity through research designs used, population size, and strict protocols. Studies published by Lim (2010, 2011) provide evidence for the use of music therapy with the ASD population utilizing song compositions as well as Applied Behavior Analysis Verbal Behavior (ABA VB) to facilitate speech production. Both of these studies incorporate more valid research designs and larger sample sizes: the former study includes a Randomized Control Trial (RCT), while the second study uses a within subjects design in which participants undergo music, speech, and no-training conditions. Wan's (2011) study examining Auditory-Motor Mapping Training (AMMT), a technique in which one sings while simultaneously hitting drums tuned to the same pitches, used a specific treatment protocol to facilitate speech in children with ASD. All six children made significant gains in verbal production over the eight-week period of the study. While the sample size was not ideal, the

results warrant further research incorporating a larger sample size. All three studies provide an appropriate model for future research publications in the use of music to facilitate speech by incorporating larger test samples, appropriate research designs, and specific protocols, but these are only three studies that provide good evidence for the case of music therapy. More studies providing similar interventions and results are needed to establish music therapy as a valid treatment for individuals with autism.

The current study was formulated with these ideas in mind and makes progressive strides toward optimal music therapy research. For one, the current study is very similar in nature to the Lim (2010) study, “Effect of “Developmental Speech and Language Training through Music” on Speech Production in Children with Autism Spectrum Disorders.” The same population and music therapy technique (DSLM) will be employed in the current study, with comprehension and production of novel lexical terms as one of the dependent variables being measured; in the prior study, the dependent variable was verbal production, which also involved vocabulary acquisition. While Lim’s experiment used a Randomized Controlled Trial design, the present study will employ a two period crossover design, in which each subject will serve as his or her own control. Though the current study does not employ a RCT, a comparison condition will still be implemented. Therefore, if the current study yields similar results, it will strengthen the research base and further validate the use of music therapy for treatment with ASD.

Furthermore, the use of music therapy interventions in Quick Incidental Learning (QUIL) has not yet been studied. QUIL is a child’s ability to incidentally pair a word with an object without additional instruction or labeling provided from another person in the child’s environment (Oetting, Rice, & Swank, 1995). Thus, the current study is really considered a pilot study, and if results are significant in favor of the use of DSLM to facilitate and enhance QUIL

when compared to speech and control conditions, it will provide greater opportunities for further research. The study could then be replicated with a much larger sample size to increase the power. If there are similar findings with a much larger sample size, this would further encourage more collaboration between the music therapy and speech language pathology fields.

### *Research Questions*

The aim of the current study is to replicate a study by Kouri and Winn (2006), which found mixed results when comparing children's QUIL when presented with sung and spoken stories. However, these mixed findings could be a result of confounding factors, including the inaccurate assessment of QUIL and inefficient use of music, as the melody used for treatment was not originally composed for the song text used. Of interest is how the results of the original study may differ when Developmental Speech and Language Training through Music (DSLM), a specific neurologic music therapy technique, is implemented via original song compositions. Song compositions used will be developmentally appropriate and use Gestalt patterns of perception. Utilizing DSLM, the current study poses the following research questions:

1. Are children with autism able to acquire and remember novel lexical terms with limited exposure to sung and spoken story texts?
2. Does attention to video stimuli differ between the music vs. speech condition?
3. Does speech comprehension and production differ between the music vs. speech condition?

## CHAPTER TWO

### Review of the Literature

#### *Introduction*

In order to thoroughly discuss the use of music stimuli to facilitate vocabulary acquisition in children with autism spectrum disorder, it is necessary to discuss an array of topics related to both typically-developing children and children with ASD. The current review will cover word learning, strategies used in vocabulary acquisition, neurological processes in both music and speech, a comparison of perceptions in both domains, and evidence utilizing music for the acquisition of speech and language.

#### *Typical Word Learning*

It is necessary to examine the conventional strategies that typically developing children employ for word learning in order to gain further insight on parallel methods that children with autism utilize. One theory proposing how children learn new words is called the learning theory. According to this theory, children learn a word through frequent exposure to a visual or auditory stimulus (e.g. hearing someone say “dog”) paired with an event (seeing a dog). Eventually, an association is formed between the stimulus and the event or experience (Gleason, 2005). A child’s use of a new word is initially limited to the context in which the child was first exposed to the word; thus, learning theory is utilized in the early stages of development, and as children age, more efficient strategies are employed (Barrett, 1999; Gleason, 2005).

There are additional theories of language acquisition that might explain how children are able to utilize more complex strategies to learn words more efficiently – namely, the nativist, social-interactionist, emergentist, and relational frame theory. The nativist theory is based on four principles: 1) the human brain is primed to learn language 2) children have an innate

knowledge of similarities and differences in the properties of all languages 3) children only need a few basic, fundamental examples of language use in order to learn the complex system of language and 4) language learning is a modular procedure, and the human brain is primed to process complex language relationships and categories without drawing from other cognitive processes. Another theory is the social-interactionist theory, which posits that the child's social environment not only serves as the impetus to learn language, but is also responsible for shaping proficient language use and knowledge. This theory stresses the importance of a child's relationship with his/her caregiver and how caregivers can inadvertently foster or hinder the child's language development.

The next theory, the emergentist approach, is similar to the nativist theory, as it also takes the position that the human brain is primed to learn language, but there are some additional differences. For one, while the nativist approach suggests that language processing is modular and does not rely on more general cognitive processes, the emergentist approach claims the alternative view that language learning uses the same processes. The emergentist approach also proposes that learning is based on associations of language, and these associations help to establish networks that are related to and further shaped by receptive and expressive language (Abbeduto & Boudreau, 2004).

One final theory of language acquisition is the relation frame theory. The relational frame theory is based on Skinner's verbal behavior, but with more explanations regarding the multitude of relationships derived between stimuli (Roche, Barnes-Holmes, Y., Barnes-Holmes, D., Stewart, O'Hara, 2002). The relational frame theory suggests that children learn language through both cognitive and behavioral means, and language is learned based on inferences drawn from the ways in which stimuli in a child's natural environment relate to each other (Gross &

Fox, 2009). For example, if  $A=B$  and  $B=C$ , then one could infer that  $A=C$ . This form of relation demonstrates equivalence; other forms might include more/less, and same/different (Roche et al., 2002). Furthermore, children learn to respond to similar relations and contexts in the same way, and this is referred to as a relational frame. These frames continue to adapt and change over time based on reinforcement from the child's social environment (Gross & Fox, 2009).

All theories illustrate that children learn language through behavioral and growing cognitive, social, and language skills. Children learn that words can be sorted into different categories, such as objects, actions, and states. Children also learn that one word can refer to multiple referents, and that multiple words can be associated with a single object (Gleason, 2005). Both social awareness and joint attention play a role in word learning. Upon hearing a word from another person in their environment, children follow the gaze of the speaker and make an association between the word and the object or item at which the speaker is looking (Gleason, 2005). Moreover, word acquisition is dependent on various aspects of social interaction: joint attention, imitation, and the understanding of the relationship between the word and the specific context. For instance, a child's ability to use a new word in a different context parallels the mother's use of the word in different contexts (Barrett, 1999). Thus, joint attention and an understanding of the intentions and actions of others are very important in word acquisition (Gleason, 2005).

Children experience a sudden and dramatic growth in spoken vocabulary beginning at approximately 18 months of age. A similar growth rate can be observed in a child's receptive vocabulary: however, the development of receptive vocabulary precedes that of spoken vocabulary (Goldfield & Reznick, 1992 as cited in Barrett, 1999). The vocabulary spurt is strongly tied to a child's cognitive ability, as both spontaneous exhaustive sorting and fast-

mapping are essential to learning new words at a rapid pace (Mervis & Bertrand, 1995 as cited in Barrett, 1999; Gleason, 2005). Fast-mapping can be defined as the ability to learn a new word by rapidly constructing an association between the specific word and a referent (Gleason, 2005; McDuffie, Yoder & Stone 2006a). Furthermore, children use a set of assumptions or principles to further aid in fast-mapping (Gleason, 2005).

### *Word Learning and Autism*

Children with autism exhibit a high variance in language use. While some children do not use any spoken language, others' use of language parallels that of typically developing peers (Barrett, 1999; Tager-Flusberg, 1999). Looking more specifically at the different areas of language, pragmatic development in autism is one area in which impairment is evident from an early age. Pragmatics is the area of language that incorporates the contexts in which language is used to interpret meaning (Tager-Flusberg, 1999; Barrett, 1999). Areas of pragmatics in which individuals with autism experience difficulty include little flexibility in use of language, as well as an understanding that language could employ intentional meaning vs. literal meaning (Tager-Flasberg, 1999).

Another deficit in the area of socialization directly relating to pragmatics is joint attention -- the ability to attend or orient to another person in the environment, look where another person is looking or pointing, and gain the attention of others to start a conversation (Gleason, 2005). While normally developing toddlers have been observed to interpret the meaning of new words by tracking the point of reference in the speaker's line of sight (Gleason, 2005), children with autism scan only what is presented in their own visual field (Baron-Cohen, Baldwin, & Crowson, 1997 as cited in Gleason, 2005).



Tager-Flusberg (1999) postulates that difficulties in acquiring functional use of language are closely linked to deficits in the social domain characteristic of autism. This is further explained by underscoring similar deficits in both domains; for example, the author highlights a lack of imitative social play in the area of communication, which in effect could be influenced by a general lack of interest in others in the area of socialization. Research suggests that the development of a theory of mind is the underlying deficit impinging on play, communication, and social skills, as a theory of mind is the common denominator in many of the aforementioned areas of impairment. A theory of mind is the ability to understand that intentions and emotions are manifested in the actions and behaviors of oneself and others, which is related to pragmatics (Tager-Flusberg, 1999).

All of these aforementioned social skills are crucial in vocabulary acquisition. As typical children acquire spoken language, the desire to communicate with others serves as further incentive to learn language (Barrett, 1999). Given many children with autism lack social relationships with others, this additional motivation might be nonexistent. The social aspect of language acquisition greatly inhibits the ability of children with autism to learn language: these children might not be motivated to communicate with others and therefore, are unable to further learn functional use of language.

Therefore, pinpointing methods of facilitating joint attention is crucial, as this could be the key to fostering vocabulary growth and appropriate use of language. McDuffie, Yoder, and Stone (2006b) sought to determine whether referential labels during play would increase attention in children with autism as compared to play without labeling, and if typically-developing children with similar vocabularies would exhibit greater attention to novel objects in response to social cues provided by an examiner. Results demonstrated that while typically-

developing children sustained attention for an increased duration overall regardless of condition, the autism group performed similarly to typical children when object-labeling was provided. Considering the two groups in the study were matched based on similar vocabulary size, this study implies that children with autism may rely on other strategies in vocabulary acquisition (McDuffie et al., 2006b).

While the aforementioned study illustrated that labels provided by a social partner might increase joint attention in children with autism, of further interest is discovering what prelinguistic behaviors might predict future comprehension and production of new words (McDuffie et al., 2005). Twenty-Nine children with autism participated in the study, and vocabulary comprehension and production were measured using the “Communicative Development Inventory,” completed by each participant’s parents prior to treatment and six months after the conclusion of treatment. Four different prelinguistic behaviors were examined: motor imitation with and without objects, attention-following, commenting (e.g. joint-attention or shared enjoyment; for example, bright affect with eye contact with examiner), and requesting (reaching for a preferred item while making eye contact with examiner). Of the four behaviors examined, commenting and motor-imitation without objects were the only behaviors that significantly predicted vocabulary production, while commenting alone significantly predicted comprehension. The researchers further suggest capitalizing on prelinguistic behaviors by providing a label to an object in which the child with autism shows interest, further extinguishing the burden of interpreting the social intention of another person (McDuffie et al., 2005).

Of further interest is if children with an autism diagnosis utilize referential comments and/or behaviors of a social partner to assign a label to an object. Preissler and Carey (2005) sought to 1) confirm findings of prior research that children with autism have great difficulty

using social intent of others to map a label to a novel object and 2) discover if children with autism are able to use deductive reasoning in order to pair a novel label to an unfamiliar object when presented concurrently with a known object. Researchers were especially interested in whether or not other strategies could be utilized to create new mappings given the deficit in social monitoring highlighted in past research. The results indicated that the children with autism indeed experienced difficulty mapping a label to an object when provided referential cueing from a social partner, as the children in this group assigned the label provided to the object in their direct line of focus, even when the experimenter assigned the label to an object the experimenter was manipulating using eye gaze. In contrast, the typically-developing children made the correct label-object pair 80% of the time and were observed to utilize the experimenter's eye gaze significantly more than the autism group (Preissler & Carey, 2005).

Considering the second research question, children with autism performed statistically the same as typically-developing peers on a task requiring the use of deductive reasoning to pair a novel label to an unfamiliar object when presented concurrently with a familiar object. In addition to the findings from the first experiment, researchers concluded that children with autism are able to employ other strategies in order to map words to objects and thus, build vocabulary (Preissler & Carey, 2005).

Parish-Morris, Hennon, Hirsch-Pasek, Golinkoff, and Tager-Flusberg (2007) expounded on all aforementioned research examining the utilization of social cues for word learning by comparing how children with autism and typically-developing peers learn words based on attentional and intentional theories. The prior holds the premise that cueing from a social partner might not be required and movement, gestures, and manipulation of the object might better facilitate word learning. The latter theorizes that through social interaction, children can use the

social cues provided by a partner to surmise the correct label-object pairing. Fifty-one ASD and typically-developing children participated in four different experiments, and the results indicated: 1) all children were able to attend to an object relying on social information communicating the experimenter's intent. 2) When a nonpreferred object was presented in concurrence with a preferred object, ASD children often mapped the label to the object in possession, thereby ignoring the social cues of the experimenter. 3) Children with ASD were less likely to use social cues provided to execute the examiner's intended actions. 4) Only typically developing children were able to use the social intentions of the speaker in order to map a label onto a familiar object at slightly more than chance (Parrish-Morris et. al, 2007). This study implies that children with ASD do exercise intentional word learning, but the use of intentional strategies is limited when more attention to social cues is required.

#### *Strategies Utilized in Vocabulary Acquisition*

As previously mentioned, fast-mapping is crucial in word acquisition; therefore, research examining fast-mapping in individuals with autism is especially important in regard to the current study. McDuffie et al. (2006a) sought to determine if positive associations exist between attention, fast-mapping, and vocabulary growth in young children with autism. Results showed that there were significant associations between attention-following and vocabulary comprehension and production, attention-following and fast-mapping, and fast-mapping and vocabulary comprehension and production. The researchers concluded that attention serves as a foundation for accurate fast-mapping and thus, vocabulary development.

Koegel, Shirotova, and Koegel (2009) looked more closely at the role of attention in vocabulary acquisition by examining the effect of "individualized orienting cues" on three children with autism. Examiners wanted to determine if "individualized orienting cues" could be

found for each of the children and whether those cues would lead to word production. Examples of orienting cues were high fives, hugs and kisses, and a pantomimic motor action (e.g. recreating the wheels of a car with hands while simultaneously saying, “car.”) In the baseline condition, if a child took an interest in an object by looking at or reaching for it, the experimenter would provide a verbal prompt, and the child would get the object only if the child imitated or produced an approximation of the word modeled by the examiner. In the intervention, orienting cues were provided once the child expressed interest in an object, and the examiner followed the orienting cue with a verbal prompt within one second. Resulting data showed that two of the children made significant gains in vocabulary production: 0-1 words pre-test followed by 38 to 245 post-test. This supports the notion that increased attention may correlate with effective vocabulary acquisition in young children with autism.

Quick Incidental Learning (QUIL) is a more specific form of fast-mapping, in which children incidentally pair a word with an object and no additional instruction or labeling is provided (Oetting, Rice, & Swank, 1995). While studies examining QUIL with children with autism are limited, some published studies do monitor QUIL in children with specific language impairment (SLI). In a study conducted by Rice, Oetting, Marquis, and Bode (1994), QUIL of preschool children with and without SLI was examined with special attention given to frequency of exposure and the type of word; groups of words included verbs or nouns, while three different frequencies of exposure were used – 0 (Control), 1, 3, and 10. Investigators also wanted to assess whether or not a diagnosis of speech language impairment negatively impacted a child’s ability to later recall novel words as compared to typical children. Results illustrated that the number of exposures to a novel word as well as word type affects comprehension, as only typically developing children made significant gains when only exposed to a novel word three

times. While children with SLI made significant gains with increased exposure to a word, comprehension testing showed these children were unable to retain words in long-term memory, especially action words. (Rice et al., 1994).

Oetting, Rice, and Swank (1995) took the findings of the aforementioned study one step further by observing how age affects QUIL contingent upon word type and presence of SLI. Using normally developing children, researchers aimed to assess whether or not 1) school-aged children learn words in a similar manner as preschool children and 2) children ages 6-8 show marked improvements and utilization of quick incidental learning. In children with SLI, researchers wanted to examine if 1) children with SLI continue to struggle with quick incidental learning during early education and 2) they learn words from dissimilar categories at the same rate as their normally-developing peers. In general, the normally-developing children in the experimental group made significantly greater gains in vocabulary than both the control and SLI groups, while the SLI group made significantly greater gains than the control group. The experimental group with normally-developing children also made significant gains in all four word categories as compared to the control group. The SLI group made significant gains in only two of the four categories (object and affective state) when compared to the control group. Finally, results showed that school-aged children learned words in a similar manner as preschool children as greater gains were made in object and attribute categories (Oetting et al., 1995).

#### *Methods Used to Facilitate Speech Development*

DeThorne, Johnson, Walder, and Mahurin-Smith (2009) presented a comprehensive research article summarizing six strategies to utilize with young children to facilitate speech. The authors highlighted the following six strategies based on evidence and best practice: promoting Augmentative and Alternative Communication (AAC); placing minimal demands on

children to speak; imitating children as opposed to prompting the child to imitate, “exaggerated intonation and slowed tempo” (Dethorne et al., 2009, p. 138); augment other forms of sensory feedback (i.e. auditory as well as visual, tactile, and proprioceptive); and make certain that non-speech exercises and activities are used with care and the ultimate speech goal is efficiently targeted. In reference to the use of “exaggerated intonation and slowed tempo,” it appears that the authors were talking exclusively about the use of singing in speech therapy. They explain that music and speech have shared neural networks, and that by using music, speech can be neurologically targeted. Furthermore, melody in singing is similar to prosody in speech, and improved prosody creates more lucid and understandable speech patterns (Dethorne et al., 2009).

Of the six strategies listed above, utilizing Augmentative and Alternative Communication seems to be a popular approach, as there is enough of a research base to conduct a systematic review. Schlosser and Wendt (2008) examined studies published between 1975 and 2007, and eleven studies with 125 total participants were accepted based on strict criteria. The findings of the review indicated that utilizing AAC did not hinder speech, and in most cases, an increase in speech was observed. However, the increase in speech production was minimal. While AAC might provide children with ASD more opportunities to functionally communicate with others, this study shows that there is no evidence to support its use in facilitating speech production.

As previously mentioned, Dethorne et al. (2009) suggested that placing minimal demands on children to speak was effective method of facilitating speech production. Using interventions and activities that mimic the child’s natural play environment might be more effective in capturing the child’s interest and increasing participation. Hart and Gonzalez (2009) examined the effects of communication-centered intervention on phonological learning in three preschoolers with moderate to severe speech disorders. The “communication-centered

intervention” the authors refer to is joint-story book reading, conversation, and play. The selected intervention of the study used books created with target sounds in mind, as the text used repetitive phrases that included the target sounds. If the participant articulated the sound incorrectly, the researcher would present a contrast question that included one correct and one incorrect pronunciation of the word (e.g., “Is it *tad* or *sad*?”). The results of the study showed that two of the participants made improvements in target speech patterns, and one participant generalized information gained to other social contexts. Nevertheless, this study must be replicated with a larger sample size to bear any weight as a clinical modality. Furthermore, not all children with ASD would have the developmental level necessary to attend to a book, as sensory needs and intellectual functioning (i.e., reading ability, speech production, etc.) might hinder the child’s ability to participate.

Other effective strategies highlighted in Dethorne et al. (2009) article were the use of augmented sensory feedback and discretionary use of non-speech exercises, making certain that the non-speech exercise paralleled the ultimate speech goal. Bahr and Rosenfeld-Johnson (2010) support such an approach, known as Oral Placement Therapy (OPT). OPT has basically three steps: step one includes facilitating oral-motor planning involved in target speech sound via proprioceptive-tactile input (i.e., therapy tool and/or therapist); in step two, facilitation of oral-motor planning involved in target speech sound occurs without the additional proprioceptive-tactile input; and in step three, the movement mastered is used in speech with and without additional sensory input. This approach is designed for children with Oral Placement Disorder (OPD), which is a disorder in which the child has difficulty imitating words or sounds when provided with visual and auditory input and verbal instruction. In the article, the authors draw parallels between OPT and motor learning theories and present research that includes OPT. The



authors conclude by stating further research is necessary, as more insight is needed concerning effective OPT treatments and what populations can benefit from OPT. This article is relevant to children with ASD, as this population experiences difficulty imitating others; therefore, OPT could be a possible intervention to use.

One last study worth noting also utilizes a multi-sensory approach to facilitate speech in children with autism. Wan et al. (2011) examined the use of Auditory-Motor Mapping Training (AMMT), a technique in which one sings while simultaneously hitting drums tuned to the same pitches. This technique is based in music and neuroscience research that shows 1) there are shared activations in music and speech tasks, and 2) when compared to typical individuals, music tasks activate areas of the brain in individuals with autism that have abnormal activations (this will be discussed in greater detail in the following section). Six non-verbal children ages 5-9 participated in the study, which involved 40 individual sessions over an 8-week period. Results showed that all children made significant gains in verbal production, including generalization to items separate from the treatment context. While the sample size was small, the results warrant further research and consideration. However, it is worth noting that the inclusion criteria involved increased levels of cognitive ability, as children were required to exhibit sustained attention for long periods of time, follow one-step directions, and be able to Imitate. This treatment might not work as well with a child who has difficulty in any of the aforementioned areas due to sensory needs and developmental level.

### *Music and the Brain*

With gains in technology, more methods of studying the underlying neurological processes of the brain have come into existence. Thus, more is known about the functions and processes of the brain in regard to domain specificity vs. inclusivity. A popular but dated belief

was that music was solely processed in the right hemisphere of the brain. Recent research in many publications has disproved this theory. It is now known that while speech and music do have distinct areas in the brain and are organized differently, there is large overlap, especially upon initial processing of different sound categories in speech and music (Patel, 2008). Both speech and music are processed in homologue structures within the brain. Considering domain-specific processes, it is thought that pitch/melodic sounds are processed in right-hemisphere areas, whereas temporal/rhythmic sounds are processed in left-hemisphere areas.

Additional research has expounded on this idea by investigating brain regions activated during both singing and speaking tasks (Callan et al., 2006; Jeffries, Fritz, & Braun, 2003). The results of one study showed a large degree of overlap in activations in both expressive and receptive tasks, including: left planum temporale/superior temporal parietal regions, left and right premotor cortex, lateral area of the VI lobule of posterior cerebellum, anterior superior temporal gyrus, and planum polare. Distinct regions activated in the singing condition were the right planum temporale, orbitofrontal cortex, and the subcallosal cingulate – regions believed to be associated with emotional response to music. When considering hemispheric differences, distinct activation in the speech condition for both tasks was found in the left temporal lobe, while distinct activation of the singing condition for the listening task only was found in the right temporal lobe (Callan et al., 2006). Similarly, Jeffries et al. (2003) found that in general, subjects who recited words exhibited more activity in the left hemisphere, while subjects who sang words exhibited more activity in the right hemisphere. The results of the study suggest that activation lateralization was related to sensorimotor function based on the activation of the insula, which might play a role in oral-motor planning while singing (Jeffries et al., 2003). The aforementioned findings further illustrate that while speech and music do have distinct areas of

activation, they also have shared activations in speech and language regions. Moreover, these shared activations are observable in both perceptive and expressive aspects of both domains.

A similar study using Functional Magnetic Resonance Imaging reported shared activations in not only singing and speaking but humming and vowel production. Shared activations included: “inferior pre- and postcentral gyrus, the superior temporal gyrus, and the superior temporal sulcus in both hemispheres” (Ozdemir, Norton & Schlaugh, 2006, p. 632). The superior temporal gyrus in the left hemisphere is also known as Wernicke’s area, an area responsible for processing multiple sensory inputs in order to execute higher cognitive processing (Shier, Butler, & Lewis, 2004). When comparing singing and speaking conditions, singing was shown to activate a larger area including more regions in the superior temporal gyrus (specifically, the right hemisphere), “inferior aspects of the central operculum, and the inferior frontal gyrus” (Ozdemir et al., 2006, p.633). The inferior frontal gyrus is also known as Broca’s area, a region of the brain responsible for the motor planning and execution of speech (Shier et al., 2004). The large overlap and the extended activation shown while singing provides further implications for the use of singing in the habilitation and rehabilitation of speech (Ozdemir et al., 2006).

So far, the aforementioned studies have focused primarily on singing vs. speaking and the resulting activations, both distinct and shared, in the brain. It is also evident that listening to sung words also activates speech and language regions, including Broca’s and Wernicke’s areas. Even further, listening to music with no speech/language component activates speech and language areas of the brain. Maess, Koelsch, Gunter, and Friederici (2001) used Magnetoencephalography to examine neural activity while participants listened to sequences of five chords. While some sequences included all “tonally-related chords,” others included a

‘Neapolitan sixth chord’ at the third and fifth positions of the sequence (Maess et al., 2001, p. 540). Results showed that while effects of the two positions were comparable concerning allocation and time for the Neapolitan chords, the effects of the third-position chord were half as strong as the fifth-position chord. Moreover, the effects of the Neapolitan chord in fifth position on neural substrates differed significantly from homologous in-key chords. These chords caused an “early magnetic field” in both hemispheres of the inferior pars opercularis, which in the left hemisphere is Broca’s area.

This is especially interesting, considering that Broca’s area is responsible for motor coordination and planning of expressive language (Shier et al., 2004), so even in the absence of verbal expression, there is still activation with a musical stimulus. A possible explanation for this activity in the absence of a speech component is the mirror-neuron system, which is thought to be in Broca’s area, among other places in the brain (Wan, Demaine, Zipse, Norton, & Schlaug, 2010). The basis for the mirror-neuron system is that perception and comprehension of speech and language relies greatly on the observation of oral-facial musculature as well as nonverbal gestures and movements involved in spoken language. Research has shown that listening to music, which is a multi-sensory experience, activates regions of the brain that encompass mirror neurons (Wan et al., 2010). Regardless of possible mirror neuron involvement, it appears that syntactic processing in Broca’s area is not limited to language, processing of speech and music is related, and most importantly, a strong case can be made for the use of music for speech development.

#### *Neurological Processes of Speech Areas in ASD*

Considering the prior section focused on brain activation in subjects without developmental disability, it is necessary to illustrate speech processes without music stimulus in

neural areas of individuals with autism. Harris et al. (2006) studied semantic and perceptual processing in adult males with ASD and adult control males with no diagnosis using functional magnetic resonance imaging. Participants were shown three different kinds of words (concrete (object), mental state abstract (feeling), and metaphysical abstract (state of mind) across two different conditions: perceptual and semantic. In the perceptual condition, participants identified the target word presented as UPPER or lower case. In the semantic condition, participants identified the target word as positive or negative. Compared to the control group, the ASD group showed similar amounts of activation in both perceptual and semantic tasks, while the control group showed increased activation in semantic tasks, including activation of Broca's area. Findings from this study illuminate the difficulty individuals with ASD have in understanding word meaning.

The results of the aforementioned study are not surprising, given the difficulties in pragmatics this population faces, especially when considering intentional meaning vs. literal meaning. It is also plausible that the decreased activation of Broca's area in the ASD group could be linked to the mirror-neuron system, as research has shown ties between decreased mirror neuron activity in Broca's area and communication deficits in individuals with ASD (Wan et al., 2010). Given music's ability to activate regions of Broca's area and its right hemisphere homologue (Maess et al., 2001; Wan et al., 2010), this further supports the use of music to enhance language skills.

Along with different neural activity, there are also structural differences of the brain in individuals with ASD when compared to the normally-developing population. Researchers examined the volume and structure of grey matter in individuals aged 7-19 with and without ASD using MRI (Knaus et al., 2009). Specific regions studied were Heschl's gyrus, Wernicke's

area, and Broca's area. Participants' IQ and expressive and receptive language were measured prior to testing. While both groups showed significant differences in terms of age in the asymmetry of the left planum temporale, the ASD group showed larger frontal language regions regardless of age. Researchers also found a significant correlation between language and social impairments and size of frontal regions in the younger ASD children. The authors also propose that the larger right pars triangularis and its relationship with poor language scores might be due to a "lack of pruning of tissue, especially in the right hemisphere" (Knaus et al, 2009, p. 60). Based on the literature, it is known that music activates areas of the right hemisphere homologous to speech and language centers in the left hemisphere. This raises implications that through music intervention and greater activation of these areas, it may be possible to develop further language and social growth.

#### *Perception of Music and Speech Processes*

The rhythmic element of music helps to organize information that is more easily perceived and processed by individuals with autism. The transfer of information via music generates a gestalt style of perception that enables individuals with autism to make sense of abundant sensory input (Berger, 2002; Lim, 2009; Thaut, 2005). Lim (2009) observes that gestalt processes are inherent in many aspects of music, such as melody, phrasing, and rhythm. Gestalt processes aid in the sensory process (Lim, 2009), as once individuals perceive that information is ordered rather than random, higher learning can take place in executive function areas (Berger, 2002).

Berger (2002) presents the idea that melody is actually used to communicate emotion before language, as the production and perception of human calls is innate and instinctual, and does not require cognitive processing. Furthermore, McMullen and Saffran (2004) suggest that

infants are able to discern familiar vs. unfamiliar speech sounds without semantic knowledge. The rise and fall of melody parallels the rise and fall of inflection or prosody of speech. Given that music is able to access the areas of the brain that dictate whether or not incoming information will reach the neo-cortex for processing and learning, melody activates attention and creates anticipation of what is to come. Melody, like rhythm, also organizes information for easier, holistic processing. Musical form operates in a similar manner, as attention and anticipation are both involved in listening to the journey of a musical statement (Berger, 2002).

McMullen and Saffran (2004) further draw parallels between the two domains of music and language. While the authors note that the two areas occupy distinct cortical areas, they suggest that the methods children use to learn new information in both music and language are quite similar. Both speech and music have organizational systems of time and pitch, facilitating learning and easier categorization in memory. The related systems of organization intrinsic in both areas also lead to similarities in perception. Analogous learning strategies are used in both music and language to detect patterns and categorize information into memory (McMullen & Saffran, 2004).

Another commonality in the perception of both speech and music is that both stimuli activate the Mirror Neuron System (MNS) in the human brain. The production and perception of speech as well as music involve the visual, auditory, and sensorimotor systems, and in order to understand and learn both modalities, observation of the motor actions involved is essential. It is believed that many individuals with autism have a dysfunctional MNS, as evidenced by a lack of language. Music might provide an alternative method of speech habilitation, as when compared to speech, music activates an extended areas of the brain thought to contain segments of the

MNS. Given this population's ability to readily perceive music, music might be an appropriate medium to develop the MNS (Wan et al., 2010).

### *Music and implications for Speech/Language Development*

There is limited research examining music therapy's role in treating individuals with ASD, but nonetheless, the existing research offers promising implications for its use in the development of vocabulary acquisition. Given that joint attention indicates future comprehension and production of new words (McDuffie et al., 2005), it is appropriate to discuss improvisational music therapy, a technique that has been shown to facilitate joint attention. Kim, Wigram, and Gold (2008) reported that while participating in improvisational music therapy, children with ASD made significant gains in joint attention behavior, as data for eye contact and turn-taking duration was significantly greater in the music therapy condition. While the study included two different conditions (speech and play therapy), only ten children participated in the study, making it difficult to generalize the findings to the continually growing ASD population.

Other approaches involving music therapy as a treatment method for fostering communication and socialization in children with ASD utilize original song compositions and interactive instrument play. Geist, McCarthy, Rodgers-Smith, and Porter (2008) found that a collaborative treatment approach with speech therapy and music therapy utilizing the aforementioned interventions helped one child make gains in attention, socialization and communication. Similarly, Kern, Wolery and Aldridge (2007) discovered that children's ability to follow a morning greeting routine improved through the use of music via original song compositions. However, it is difficult to generalize the findings of these studies. Both studies employed small sample sizes (e.g. one child in the Geist et al. study, two in the Kern et al. study), poor treatment designs, and statistically significant results were not reported. While these



studies provide emerging evidence that music therapy techniques could improve communication and socialization skills in children with ASD, research studies with larger sample sizes as well as appropriate experimental designs are necessary to establish music therapy as a valid treatment for speech and language and social development.

Lim's (2010) study looking more specifically at vocabulary acquisition and speech production is one such study. Lim examined Developmental Speech and Language Training through Music (DSLM), and the implications of its use for the habilitation of multiple aspects of speech production (i.e. semantics, phonology, pragmatics, and prosody). There were 50 participants with autism organized into three different groups: a music group, speech group, and control group. The investigator composed six songs, which included a target word at the end of each phrase, six words per song for a total of 36 words. Gestalt laws of perception were also utilized in the composition of all songs, as pitch intervals were small and moved in step-wise patterns and target words were emphasized in the music by cadences and melodic/rhythmic patterns. The speech condition used the same text but did not use music; however, target words were placed at the end of phrases, and the same individual who performed the songs in the video of the music condition also read the stories in the speech condition (Lim, 2010).

Results showed that both treatment conditions had significant effects concerning improvement in speech production. While the music condition yielded greater gains in speech production than the speech condition, it was not at a level of significance. However, the music condition was more effective in speech production for participants with low-functional language skills than the speech condition (Lim 2010). One point worth noting is that participants in the music training group exhibited increased attention levels, based on observed behavior and spontaneous utterances of words from songs. Conclusions of the study suggest that further

replications could examine the effects of increased training sessions, categorization of target words, a distinct level of functioning (i.e. mild, moderate, severe, etc.), generalization of knowledge gained from training, different components of musical stimuli, and prompting participants to sing along with the music (Lim, 2010).

The study also takes a progressive step in validating music therapy for habilitation of speech and language in children with autism. Along with increased sample size and treatment design, the music treatment in the study was implemented by a trained music therapist and utilized Gestalt patterns of perception in the composition of the music and text. The music used was also developmentally appropriate for the age range of children (Lim, 2010). The researcher also used a specific neurologic music therapy technique known as “Developmental Speech and Language Training through Music,” which is based on sound research in neurology, psychology, and speech and language development (Thaut, 2005), and can easily be replicated in both treatment and future research.

Another study by Lim (2011) examines speech production in children with ASD utilizing an Applied Behavior Analysis Verbal Behavior (ABA VB) approach within music, speech, and no training conditions. ABA VB is a method of teaching children with ASD functional language using an Applied Behavior Analysis model that includes shaping and reinforcement, as well as careful observation regarding the child’s use of language and the function behind it. While the study did not employ a RCT, the study did use a within subjects design in which each of the 22 children received a random set of words in all three conditions, and the order in which each child participated in all three conditions was randomized; thus, each child served as his/her own control. Four elements of ABA VB were examined in the study, including mand (i.e., requesting a desired item or activity), tact (i.e., labeling objects and/or pictures), echoic (i.e., imitating

another individual's verbalizations) and intraverbal (i.e., finishing a sentence or statement). A music therapist used DSLM by composing melodies to match the sung verbal instruction used in the music condition. Similar to Lim's 2010 study, target words were placed at the end of each phrase, and were developmentally appropriate for the age range studied (i.e., 3-5 years). The same verbal instructions used in the music condition were also used in the speech condition. All texts included 30 words/phrases: 18 target words for mand, six words each for tact, six phrases for echoic, and six words for intraverbal.

Results showed that verbal production in all four elements of ABA VB was significantly greater in speech and music conditions when compared to no training; however, the difference between speech and music conditions was not significant. Thus, the study provides evidence that both music and speech intervention are equally effective methods to facilitate speech production in children with ASD in the ABA VB context. Additionally, results showed a significant effect of music training on participants' ability to produce target phrases from the echoic category and speech training on participants' ability to produce target words from the tact category (Lim, 2011). This study further contributes to the literature that draws parallels in the perception of speech and music, and suggests that music intervention is as effective as speech intervention to facilitate speech production in children with ASD. Furthermore, the significant effect of music training on echoic production might indicate that carefully constructed music interventions might help children with ASD learn functional phrases in the ABA VB context.

Similar to the previous studies, Kouri and Winn (2006) also used song vs. speech presentation to examine participants' Quick Incidental Learning. Sixteen preschoolers with language delays and/or developmental disabilities were exposed to either scripted or sung stories to examine how these two conditions correlated with comprehension and production of new

lexical terms. Although this study did not state that any of the participants had the diagnosis of autism, four participants did show significant language delay, which is characteristic of many individuals with autism (Kouri & Winn, 2006; Rapin & Dunn, 2003). Both stories used were equal in length. In the sung condition, the words of the story were set to the tune, *Down by the Bay*. Four lexical terms were embedded in both stories at the beginning or ending of phrases. Props were also used and paired with each new lexical term. While the results of the study indicated that recognition and generalization of new lexical terms did not differ between groups, spontaneous imitations of the lexical items increased significantly in the second session during the sung condition.

This study has flaws and confounding factors that need to be discussed further. First, it is difficult to determine which condition is actually more effective, as all participants were exposed to the sung and spoken scripts of each story. Participants were randomly placed into two groups, but groups were not organized by condition (i.e. sung script, spoken script), but type of presentation. For example, one group listened to sung story #1 and spoken story #2 while the other group listened to sung story #2 and spoken story #1. Each group then switched to hear the opposite version of each story. The researcher reported that both experimental sessions were conducted within five days, but based on the design of the experiment, there is no baseline to use for comparison in order to assess whether or not participants' QUIL showed greater improvements in the music or speech condition.

There is also a discrepancy in the study concerning the examination of QUIL. QUIL is when children incidentally pair a word with an object and no additional instruction or labeling is provided (Oetting, Rice, & Swank 1995). In the Kouri and Winn (2006) study, the researcher reports not only pointing to target objects, but stopping the presentation of the song or script and

regaining the participant's attention before resuming. No data was taken concerning how many times the researcher stopped either the sung or spoken script, and it is logical to assume that redirecting could have played a role in the comprehension and/or production of a target word.

It is also crucial to mention that the melody of the songs used was not specifically created for the word script or the examined participants and might not have accurately used elements of music to emphasize target words in the text or to parallel children's general developmental level. Lim's (2010) study efficiently utilized the music in order to provide simple structure and some predictability of target words by placement, cadence, and rhythmic/melodic patterns. A trained music therapist is equipped to use the neurologic music therapy technique, Developmental Speech and Language Training through Music, a research-based protocol. Given the aforementioned factors, replication of this study is necessary to more appropriately assess the effectiveness of music on children's QUIL.

#### *Summary of Literature Review*

Typical vocabulary development is marked by rapid learning of new words utilizing various strategies in cognitive, language, and social skills. While children initially rely on more primitive forms of word learning, as children age they increasingly depend on the interactions with others to learn more about their environment. Considering most children with ASD experience great difficulty with pragmatics in language, joint attention, and the development of a theory of mind, children with ASD may use other strategies to further develop vocabulary. Further research has shown that children with ASD who exhibit greater levels of joint attention are more apt to learn novel words at a greater rate. Hence, while children with ASD are able to use some intentional learning to map a label to an object, children might utilize attentional means

with increasing uncertainty and difficulty interpreting social cues -- especially combined with personal beliefs and experiences.

According to research examining neural mechanisms, music activates homologous regions of the speech centers of the brain and there is extensive overlap in activations for both domains. Furthermore, the inherent structure and organization of music is more readily perceived by neural mechanisms. Thus, through shared activation, the proper use of music could facilitate the learning of new skills in the speech and language domain. Especially considering QUIL in children with autism, the intrinsic nature of coordinated music stimuli could gain immediate attention, making it easier to learn words in the natural environment.

Recent research examining the use of music therapy and children with ASD only provides emerging evidence that the proper use of music can improve speech and language development. The aforementioned studies employed small sample sizes, highly individualized treatment approaches, and inefficient use of music stimuli. The results of Lim's (2010, 2011) studies provide strong implications that DSLM might help to improve children's learning given gains in attention, spontaneous utterances of target words, and significant effect on ABA VB echoic production. Further studies examining DSLM are necessary to validate its use in the habilitation of speech and language in children with ASD.

## CHAPTER THREE

### Methods

#### *Participants*

Eight children with a diagnosis of Autism Spectrum Disorder (ASD) were recruited to participate in the current study in the Southeast Missouri area. The age range and mean for recruited children was 3 years, 11 months to 5 years, 8 months ( $M = 4.7$ ). All children had a prior diagnosis of autism from a personal healthcare provider, and exhibited the following characteristics of autism as identified by the American Psychiatric Association (APA), (2000): noticeable deficits in social interaction with others and communication, as well as a narrow and limited selection of activities and interests. To avoid confounding factors, children who had multiple diagnoses including autism were excluded from participating in the current study. Another requirement for inclusion in the study was the use of English as a primary language. Participants were not excluded based on ethnicity, gender or level of functioning. Recruitment of participants for the current study commenced following approval from the Colorado State University Institutional Review Board for the protection of human subjects on September 12, 2011.

*Age range.* For the current study, children ages 3-5 years old were recruited, as this age range was used in experiments after which the current study was modeled (Lim, 2010; Kouri & Winn, 2006). There are other reasons for examining children in this age range when compared to typically-developing children. By around 12-months of age, infants are able to use approximately 50 words (Gleason, 2005). When infants are approximately 18-months old, a vocabulary spurt occurs, in which infants are able to transition to more complex methods of word-learning that capitalize on growing language, cognitive, and social skills (Barrett, 1999;

Gleason, 2005; Tager-Flusberg, 1997). By the time children are preschool age, they know a plethora of words from different categories, the meaning of those words, and understand the pragmatics of language – that language used is dependent upon the social context (Barrett, 1999; Gleason, 2005; Tager-Flusberg, 1999).

Children with autism typically display a similar pattern of language in infancy until approximately 15 months of age, at which point a marked change in communicative behavior is observed and language skills regress. This regression often takes place before the vocabulary spurt, and thus, children with ASD have not mastered more complex methods of language acquisition, and word learning depends on associations between labels and objects (Tager-Flusberg, 1997). Given children with ASD have difficulty exhibiting joint attention, understanding pragmatics, and orienting to social cues, the social aspect of word learning needed to rapidly build vocabulary is absent. Research also indicates that prelinguistic behaviors, such as joint attention and imitation, not only predict later vocabulary acquisition (McDuffie, Yoder, & Stone, 2005), but need to be the focus of intervention, as this emphasizes the contexts of social interaction (Tager-Flusberg, 1997). The literature also suggests that language acquisition before the age of five is crucial for speech and language development (Barrett, 1999; Lim, 2010). Therefore, pinpointing methods of facilitating joint attention with this age range, especially in the Quick Incidental Learning (QUIL) context, is especially important.

*Level of functioning.* It is important to acquire functioning level for each participant, as the level of autism (i.e. mild, moderate, and severe) might correlate with the ability to acquire novel lexical items; therefore, level of functioning was used as a covariate in the current study. In order to determine level of functioning, a rank from the Childhood Autism Rating Scale (CARS) was obtained for each child (Schopler, Reichler, & Renner, 1988). The CARS is a



rating scale for autism drawn from five major classifications used to form a diagnosis. This assessment tool is used for children age 2 and up, and is well-established with over 15 years of development and more than 1500 cases. It is comprised of a brief 15-point checklist completed by a clinician that covers the overall functioning and development of the child, including socialization, emotional expression/emotion, body use, sensory responses, and cognition. Each item is ranked from 1-4 based on severity or peculiarity of observed behavior. The CARS identifies the level of autism as either mild-moderate or severe, and distinguishes autism from other diagnoses or developmental delays.

*Speech production.* Prior to experimental sessions, phonological inventory was determined for each child. This measure was taken in the Kouri and Winn (2006) study, as a measure of the subject's current speech level and overall phonological pattern was needed to assess production of lexical items from pre-test to post-test (lexical probing). In this portion of the experiment, the examiner said a novel lexical term while presenting the referent or novel object matching the term and prompted the participant to imitate the term. For this portion of the assessment, the examiner recruited a Speech Language Pathologist (SLP), as a SLP was able to determine the participant's phonological inventory by listening and observing each participant utter the novel lexical term. Both the pre- and post-test were recorded to digital media in order to aid the recruited SLP in baseline and post-treatment assessment.

### *Materials*

*Novel lexical items.* The same novel lexical items used in the Kouri and Winn study (2006) were included in the current study. In the prior experiment, the selection of lexical items was based on early occurrence of phonemes as well as types of syllables. Novel target words were matched in syllable shape and phoneme placement across both story scripts. Therefore in

the current study, target words for the first script included: *nagoo*, *kipee*, *mabber*, and *daynee*. Target words for the second script included: *paygo*, *teeky*, *widder*, and *bima*. Each of the target novel words were paired with a novel object. Novel objects used in the Kouri and Winn study were constructed using various items easily obtained from local stores, such as plastic containers, tin foil, cotton balls, paint, and a butter spreader. In order to accurately replicate the novel items used in the prior study, the examiner created novel objects based from the materials list provided in the appendices of the replicated study. Novel objects were presented to a small group of adult judges, who were unable to guess the names of the objects. Therefore, the objects created were used in the study.

*Music scripts.* For true replication of the Kouri and Winn (2006) study, two different scripts were created and presented in both sung and spoken form. However, a specific music therapy technique, Developmental Speech and Language Training through Music (DSLM), was used in the current study. DSLM “is designed to utilize musical as well as related materials to enhance and facilitate speech and language development in children with developmental speech and language delays” (Thaut, 2005, p. 173). Interventions utilizing DSLM might include singing exercises, instrument play, and even building vocabulary through songs utilizing instruments or pictures paired with words. Structurally organized music experiences that are appropriate for the child’s developmental level may help to facilitate vocabulary acquisition.

As in the Kouri and Winn study (2006), an average MLU for each script was 4-5, as the scripts from the replicated study were 4.73 and 4.70 respectively. Lim (2010) also utilized scripts with limited vocabulary words. When composing both songs, each song was composed in a different key and meter to distinguish one from the other. Similar to the Lim (2010) study, Gestalt laws of perception were utilized in the composition of all songs, as pitch intervals were

small and moved in step-wise patterns. Target words were placed at the end of phrases, complete with half and full cadences and sustained note durations. Rhythmic and melodic patterns were used to further identify target words of both scripts. Songs composed in such a manner are believed to be developmentally appropriate for the age range examined in the current study (Lim, 2010). Furthermore, songs that employ repetitive patterns that move toward completion via musical cadences create both predictability and anticipation, aiding in the perception of target words.

All songs and scripts were recorded on a DVD and presented to each participant via computer monitor. Guitar accompaniment was used for both songs, and the examiner used GarageBand initially to record the songs to a CD. The examiner created videos by playing both songs via CD player and lip syncing with the words, so it appeared to the viewer that the examiner was singing the song. As the examiner mouthed each lexical term from the song, the examiner also presented the corresponding novel object or referent. Considering previous studies examining QUIL with Specific and Language Impairment (SLI) found that frequency of exposure correlated with comprehension of novel referents (Rice, Oetting, Marquis, & Bode, 1994), each target word was used in the assigned song two times, and the song was repeated three times. Therefore, participants were exposed to each lexical item a total of six times. This is slightly different than the Rice et al. study (1994), which found that participants with SLI were able to acquire lexical items when exposed to the item ten times. Given the examiner sought to determine whether there were differences in QUIL contingent upon the presentation type (sung or spoken), the examiner believed slightly decreasing the frequency might further illuminate those differences.

*Spoken scripts.* The texts used in the two music compositions were also used in the two spoken scripts. Furthermore, the same novel lexical items were used, and the spoken scripts incorporated the same phrase and overall script length, as well as repetition and placement of novel lexical items. Moreover, lexical items were placed at the end of phrases. As in the sung condition, the two story scripts were recorded on DVD and presented via a computer monitor. Again, the examiner recorded the spoken scripts to a CD first, and played the CD of both stories and moved mouth along with the words, so it appeared to the viewer that the examiner was telling the story. As in the sung script, the examiner presented the novel object upon saying the matching target lexical item within the spoken script. Each script was repeated three times; thus, participants were exposed to each target lexical item six times.

### *Research Design*

Similar to the Kouri and Winn (2006) study, the current study utilized a two period crossover treatment design, in which each participant served as his or her own control by receiving both sung and spoken presentations of the two different scripts. Each participant was randomly assigned to Group one or Group two, and each group had 4 participants. During the first experimental session, Group one participants heard “Song Script A” and “Spoken Script B,” while Group two participants heard “Spoken Script A” and “Song Script B.” In the second experimental session, each group was exposed to the opposite versions of the scripts presented in the first experimental session. Thus, Group one participants heard “Song Script B” and “Spoken Script A,” while Group 2 participants heard “Spoken Script B” and “Song Script A.” Participants in both groups completed three total sessions: in the first session, the participants’ phonological inventory was acquired, and in the second and third sessions, participants completed two experimental sessions, and lexical probing ensued after each experimental

session. To limit potential carryover effects between pre-test and both experimental sessions, all sessions were conducted at least 24 hours apart. The examiner completed pre-testing, experimental sessions and lexical probing sessions for each participant within 3-5 days.

Participants were tested individually. Treatment participants watched and listened to three repetitions of two different story scripts: three repetitions of the song script and three repetitions of the spoken script, contingent upon condition assignment. After completing the experimental session, participants were given a short break, and then lexical probing was administered, in which the examiner measured the participant's production, comprehension, and generalization of each of the eight target lexical items. The second experimental session was administered the following day with the exact same format.

Edible reinforcements (e.g. crackers) were provided for all participants upon completing one type of presentation and avoiding behaviors that negatively impact perception of the video stimuli (e.g. crying, tantruming, etc.). If any of the participants had food allergies (according to the participant's parents prior to initiating the experiment), other forms of reinforcement were used, such as stickers. When a participant received two of the aforementioned reinforcements, implying the participant made it through both presentations while exhibiting appropriate behavior, a smaller prize item was rewarded (e.g. a small toy that is relatively inexpensive -- \$1 or less.)

*Data collection.* The lexical probing session was recorded and viewed by the recruited SLP to appropriately assess correct production of the novel term. The assessment information on each participant's phonological inventory was used as a baseline to determine if novel terms were produced correctly in the post-test. In agreement with Kouri and Winn (2006), the current study mimicked the same procedure in order to determine if there were differences in production,

comprehension, and generalization, as measured by number correct in each of the three categories, contingent upon the type of script (sung vs. spoken). For production probing, the examiner presented one of four novel objects matching a novel lexical term, and asked the participant to identify the item, and as previously mentioned, a recruited SLP watched this portion of the video to determine a correct/incorrect response. For comprehension, one novel lexical item was presented along with three other distracter items, which included one other target, novel object and two objects believed to be unknown to the child. Examiner presented the novel lexical item and three distracter items in random order. A response was recorded “correct” if the child touched or pointed to the correct referent matching the novel lexical term on the first attempt. The generalization segment was comparable to the comprehension stage, except a generalization object very similar to the target object was presented along with three distracters, one of which was also an experimental object. Once again, responses were recorded correct if the child touched or pointed to the referent, in this case, a generalization object, matching the target lexical item on the first attempt.

*Measures of attention.* Attention to sung and spoken scripts was examined in the study. In order to examine attention, data for duration of eye gaze was obtained throughout each training session. A video camera was placed above the computer screen from which the video stimulus was played, and attention to the stimuli was recorded from the point the participant looked at the computer screen. Recorded time stopped as soon as the participant looked away. This process continued throughout the training session each time the participant looked at the computer screen. The total duration of eye gaze instances was divided by the duration of the particular script trial; therefore, a proportion of attention was obtained for each participant to measure attention across both sung and spoken scripts. This is consistent with McDuffie et al.

(2006a), who obtained proportions of eye gaze to measure attention in the same fashion. Two different people watched experimental sessions to examine and control for inter-rater reliability in data collection.

#### *Data Analysis Procedures*

An Analysis of Covariance (ANCOVA) was used to analyze the data, given each participant's level of functioning cannot be controlled by the experimenter. Therefore, level of functioning using the CARS score obtained for each participant was considered a covariate. The independent variables of further interest were the different script presentations: sung or spoken. The dependent variables were the number of correct responses in production, comprehension, and generalization sections of lexical probing, as well as the proportion of attention. In order to control for inter-rater reliability, a Pearson's Correlation Coefficient was obtained by comparing two raters proportions for all of the 8 subjects. Under this procedure, the null hypothesis assumes there will be no correlation between the two raters data. The analysis indicated a strong positive correlation between the two raters [ $r(32) = .92 < p .0001$ ]; therefore, the null hypothesis of no correlation was rejected, and original data accumulated was used.

## CHAPTER FOUR

### Results

The present chapter examines the results from the Analysis of Covariance (ANCOVA) conducted using SAS software. The “mixed” procedure was used, given the random and mixed effects present in the current experiment. In addition, a “least squares means statement” comparing the differences of the least squares means was used to pinpoint the interaction between the response variable of interest (i.e. attention, production, comprehension, and generalization) and fixed effects, such as group assignment, session, script, and presentation. The CARs score was also added as a covariate. The statistical analysis was interpreted by referring back to the three research questions which comprise the focus of the current study. Refer to Table 1 for the raw data for each participant and includes the response variables and the CARs score.

Table 1

*Raw Data for Each Participant for Production, Comprehension, Generalization, and Attention*

Production				
Participant	Lake Song	Lake Spoken	Playground Song	Playground Spoken
1 (47.5) <sup>n</sup>	0	0	0	1
2 (48) <sup>n</sup>	0	1	2	0
3 (39) <sup>n</sup>	4	1	0	1
4 (38.5) <sup>n</sup>	2	0	0	0
5 (39.5) <sup>n</sup>	0	0	0	0
6 (31.5) <sup>n</sup>	0	1	2	0
7 (36.5) <sup>n</sup>	0	0	0	0
8 (29.5) <sup>n</sup>	2	1	0	0

<sup>n</sup> CARs scores for all participants; higher rank correlates with severity of autism.

(continued)



Table 1

*Raw Data for Each Participant for Production, Comprehension, Generalization, and Attention*

Comprehension				
Participant	Lake Song	Lake Spoken	Playground Song	Playground Spoken
1(47.5) <sup>n</sup>	1	1	4	2
2(48) <sup>n</sup>	1	2	4	2
3(39) <sup>n</sup>	3	1	0	2
4(38.5) <sup>n</sup>	2	4	3	1
5(39.5) <sup>n</sup>	1	0	1	3
6(31.5) <sup>n</sup>	3	4	4	4
7(36.5) <sup>n</sup>	1	1	1	1
8(29.5) <sup>n</sup>	4	3	1	3
Generalization				
Participant	Lake Song	Lake Spoken	Playground Song	Playground Spoken
1(47.5) <sup>n</sup>	1	1	3	3
2(48) <sup>n</sup>	2	3	3	2
3(39) <sup>n</sup>	3	1	0	1
4(38.5) <sup>n</sup>	3	4	1	2
5(39.5) <sup>n</sup>	1	3	3	4
6(31.5) <sup>n</sup>	2	1	0	0
7(36.5) <sup>n</sup>	1	0	0	1
8(29.5) <sup>n</sup>	2	3	0	3
Attention				
Participant	Lake Song	Lake Spoken	Playground Song	Playground Spoken
1(47.5) <sup>n</sup>	62%	68%	71%	78%
2(48) <sup>n</sup>	88%	75%	67%	79%
3(39) <sup>n</sup>	74%	66%	52%	58%
4(38.5) <sup>n</sup>	59%	93%	79%	75%

<sup>n</sup> CARs scores for all participants; higher rank correlates with severity of autism.

(continued)

Table 1

*Raw Data for Each Participant for Production, Comprehension, Generalization, and Attention*

Participant	Lake Song	Lake Spoken	Playground Song	Playground Spoken
5(39.5) <sup>n</sup>	34%	24%	41%	34%
6(31.5) <sup>n</sup>	90%	80%	90%	78%
7(36.5) <sup>n</sup>	43%	37%	37%	48%
8(29.5) <sup>n</sup>	93%	93%	85%	92%

<sup>n</sup> CARs scores for all participants; higher rank correlates with severity of autism.

*Research Question #1: Are children with autism able to acquire and remember novel lexical terms with limited exposure to sung and spoken story texts?*

The descriptive results are shown in Table 2, in which means and standard errors for all three aspects of word learning are listed. The standard errors listed in each of the three categories take into account the random effects.

Table 2

*Means and Standard Errors of Production, Comprehension, and Generalization of Lexical Items in Sung and Spoken Presentations*

	Production	Comprehension	Generalization
Presentation Type	<i>M (SE)</i>	<i>M (SE)</i>	<i>M (SE)</i>
Song	.75 (.26)	2.13 (.38)	1.69 (.41)
Spoken	.44 (.26)	2.13 (.38)	2.13 (.41)

Recall that, contingent upon group assignment, each participant heard two different script presentations (i.e. “Song Script A” followed by “Spoken Script B”) in one experimental session, and scripts were reversed and presented differently for the second experimental session (i.e., the same participant heard “Song Script B” followed by “Spoken Script A”). Moreover, the analysis

indicated that the second experimental session had a significant effect on production of novel lexical items [ $F(1, 19) = 5.17, p < .03$ ]. However, the experimental session did not have a significant effect on comprehension of novel lexical items [ $F(1, 19) = p < .08$ ] or generalization of novel lexical items [ $F(1, 19) = p < .17$ ]. Refer to Table 3 for total number of lexical items produced, comprehended, and generalized from Session One to Session Two.

Table 3

*Totals of Lexical Items in Each Experimental Session*

Lexical Items	Session	
	1	2
Produced	4	15
Comprehended	28	40
Generalized	26	35

*Research Question #2: Does attention to video stimuli differ between the music vs. speech condition?*

To answer the second question, data was pulled from the ANCOVA run to examine the effects of the following explanatory variables: session, script, presentation, and script/presentation on levels of attention. The results of the analysis indicated that there was no significant difference in attention to video stimuli in the music or speech condition [ $F(1, 19) = p < .76$ ]. In fact, the means and standard errors for attention in the two different presentations were almost equal (Sung Presentation:  $M = 66\%$ ,  $S.E. = .08$ ; Spoken Presentation:  $M = 67\%$ ,  $S.E. = .08$ ).

*Research Question #3: Does speech comprehension and production differ between the music vs. speech condition?*

To answer the third and final question, three different ANCOVAs were conducted to examine the effects of all explanatory variables on each of the three response variables relating to QUIL of novel lexical items. Results demonstrated there were no significant differences in production, comprehension, and generalization of novel lexical items between the sung and spoken presentations. Refer to Table 4 for statistical data showing significance for each of the three categories of word learning examined.

Table 4

*Differences in the Number of Lexical Items Produced, Comprehended, and Generalized Contingent upon Sung or Spoken Presentation*

Response Variables	<i>df</i>	<i>F</i>	<i>p</i>
Production	1, 19	1.07	.31
Comprehension	1, 19	0	1
Generalization	1, 19	0	.27

While there were no significant differences in any of the three aspects of word learning examined in the current study, it is relevant to include totals of novel items produced, comprehended, and generalized in sung and spoken stories, as this will be discussed in the next chapter. These totals are presented in Table 5.

Table 5

*Numbers of Lexical Items Produced, Comprehended, and Generalized in Both Presentations*

Lexical Items	Sung	Spoken
Produced:	12	7
Comprehended:	34	34
Generalized:	27	34

It is also necessary to examine the effect of a specific script on production of novel lexical items. While the differences were not at a level of significance, it appears that “The Lake” script (i.e., totals of both sung and spoken presentation) yielded the same amount of productions as both sung script presentations. Differences in production contingent upon script yielded the same F-ratio and  $p$  value as presentation type [ $F = 1.07 (1, 19); p < .31$ ]. Table 6 presents a more detailed look at levels of production, comprehension, and generalization in the four different story/presentation combinations.

Table 6

*Levels of Production, Generalization, and Comprehension Across All Stories/Presentations*

Script/Presentation	Produced	Comprehended	Generalized
Lake Song	8	16	15
Lake Spoken	4	16	17
Playground Song	4	18	12
Playground Spoken	3	18	17

## CHAPTER FIVE

### DISCUSSION

The present study sought to examine if children with autism spectrum disorders (ASD) could use Quick Incidental Learning (QUIL) in order to learn novel terms when presented with sung and spoken stories, if there were any differences in learning contingent upon the type of presentation (i.e. sung or spoken), and if levels of attention were different contingent upon the type of presentation (i.e. sung or spoken). A CARs score was obtained by having a parent complete the assessment for each participant. Eight children with ASD completed the assessment and two experimental sessions in a 3-5 day period. Each experimental session was followed by lexical probing, in which the researcher assessed each child's ability to produce, comprehend, and generalize the novel lexical terms presented in the videos. A speech language pathologist assisted with this portion of the study by watching the production portion of the lexical probing session to determine that the word produced was in congruence with the specific child's overall speech pattern. Attention was also measured by obtaining a proportion of eye gaze: eye gaze duration in the numerator, total script time in the denominator.

This chapter will expound on the statistical data reported in the results section. The results will be analyzed in greater detail and compared to other research presented in the review of the literature. Clinical implications, limitations of the study, and recommendations will also be presented.

#### *Discussion of the Research Questions*

Before discussing the research questions, it is pertinent to identify the problem with using the score obtained from the CARs assessment as a covariate. This assessment determines the severity of autism based on an overall score from 15-60, and a higher score correlates with

greater severity of autism. As previously mentioned, the parent of each participant completed the form. The researcher believes this resulted in inaccurate scoring for level of functioning of each participant. As Table 1 of the results section shows, there was high variability in levels of production, comprehension, generalization, and attention when looking specifically at the CARs score as an explanatory variable. Therefore, when examining the research questions, the CARs score will not be included in the independent variables discussed.

The results of this study indicate that children with ASD are able to learn novel lexical items with limited exposure. While production of novel lexical terms was not robust given either presentation, in the sung presentation, five of the eight participants were able to produce two to four words by session two, eight participants comprehended one to four lexical items by session two, and six participants generalized two to four lexical items by session two. Furthermore, there was a significant difference in production in session two compared to session one. This is comparable with the Kouri and Winn (2006) study, as researchers found that in the sung presentation, 12 of 16 participants named one to four lexical items, 15 participants exhibited comprehension by naming one to four lexical items, and 12 participants exhibited generalization of lexical items by naming one to four items by session two. Looking at the spoken presentation, the results of the current study found that seven participants produced one lexical item, and eight participants comprehended and generalized one to four target lexical items by session two. In comparison, the Kouri and Winn (2006) study found that in the spoken condition, 10 participants produced one to three lexical items, 15 participants comprehended one to four lexical items, and 16 participants generalized one to three lexical items by session two.

The results of the current study parallel findings in the literature that children with autism are able to learn novel words given both speech and music stimuli (Kouri and Winn, 2006; Lim,

2010, 2011). The findings are also consistent with research presenting the similarities in the perception of speech and music stimuli, as both speech and music have organizational systems that facilitate learning and more efficient storage in memory (McMullen and Saffran, 2004). Furthermore, the results make sense given the body of research that illustrates the overlap in activations in neural processes during speech and music tasks (Callan et al., 2006; Jeffries, Fritz, & Braun, 2006; Maess, Koelsch, Gunter, Friederici 2001; Ozdemir, Norton, & Schlaug, 2010). While production of novel lexical items was not huge, the mean number of novel lexical items comprehended was approximately two per presentation type, while the number of novel lexical items generalized was approximately two in the spoken presentation, and 1.69 in the sung presentation.

According to the results, there was no significant difference in attention when looking at sung verses spoken presentation. In fact, the means for each presentation were a mere 100<sup>th</sup> of a percent apart, as the mean proportion for the spoken presentation was 67%, while the mean proportion for sung presentation was 66%. While there were one or two subjects who exhibited high levels of attention as well as high numbers of correct responses in production, comprehension, and generalization, this is not enough evidence to show a correlation between attention and word learning. Therefore, the results of the current study do not add to research that suggests increased levels of attention in children with ASD lead to greater vocabulary acquisition (Koegel et al., 2009; McDuffie et al., 2006a).

In addition, the results did not show significant differences in production, comprehension, and generalization of novel lexical items when comparing the sung and spoken presentations. While there was a greater number of lexical items produced in the music condition compared to the speech condition, this was not at a level of significance. This is consistent with Kouri and



Winn (2006) and Lim (2010), as both studies reported increased word learning as a result of music stimuli, but not at a level of significance. The results of the current study support findings from aforementioned research that music and speech are equally effective in facilitating word learning (Lim, 2010, 2011). It is possible that no significant differences were observed due to the similar perception of speech and music processes. Both types of presentations used the same scripts which were relatively short in length, and target lexical items were placed at the ends of phrases in all scripts. Moreover, both scripts, sung and spoken, were organized in time and structure, aiding in the perception of target lexical items.

Furthermore, it is crucial to discuss how the changes made to the current study yielded some different results in comparison to the Kouri and Winn (2006) study. In the prior study, each subject heard a lexical item 10 times per script presentation. In the present study, each subject heard a lexical item 6 times per script presentation. The researcher decreased the number of times each participant heard a lexical item based on findings that children with SLI learned novel words similarly to typical children when exposed to a word 10 times (Rice et al., 1994). Given the examiner sought to determine whether there were differences in QUIL contingent upon the presentation type (sung or spoken), the examiner believed slightly decreasing the frequency might further illuminate those differences. In the current study, children were able to produce a maximum of four words from a sung script and a maximum of one word from a spoken script with decreased exposure to target lexical items. In the Kouri and Winn (2006) study, children produced a maximum of four words from a sung script and three words from a spoken script when exposed to each target lexical item 10 times per script. Given the decrease in frequency for each lexical item that the current study used, an observable difference emerged in the number of words produced contingent upon presentation. When observing the numbers, 12

total words were produced given the sung presentation, while only 7 words were produced given the Spoken presentation – this is nearly half of the words produced in the sung condition.

In addition, the mean number of words produced given the lake song was 1, which is higher than the mean of the lake spoken (.75), mean of sung presentation (.75), mean of spoken presentation (.44), the mean of the playground story (.38), and the playground song (.50). Given this information, it appears that the sung presentation and lake script (regardless of presentation type), yielded higher mean productions of target lexical items. The differences in presentation, story, and the interaction between presentation and story, although insignificant, are interesting and will be discussed further in the following section. The results of the study add to the research that music is easily perceived by children with autism due to its innate structure and organization (Berger, 2002; Lim, 2009; Lim 2010; Thaut, 2005), and further support that music intervention is as effective as speech intervention in the habilitation of speech.

### *Clinical Implications*

The current study is among the first to examine the use of Developmental Speech and Language Training (DSLTM) to facilitate Quick Incidental Learning in children with Autism Spectrum Disorders (ASD). The current study replicated the Kouri and Winn (2006) study in order to determine if original song compositions that properly utilized gestalt laws of perception would have a greater effect on children's ability to learn novel lexical items with limited exposure. Another reason for replication was to determine if the proper utilization of QUIL – allowing children to learn novel lexical items incidentally and without assistance from another person – would result in different levels of novel lexical items produced, comprehended, and generalized. Both studies found that more novel items were produced given sung presentations; however, this was not at a level of significance. Considering there appears to be a link between

attention and comprehension and production of novel words (McDuffie et al., 2005; McDuffie et al., 2006a), the current study also monitored eye gaze to the video stimuli in order to determine if levels of attention differed contingent upon script presentation. Results showed that attention to video stimuli across both types of presentations was fairly constant.

The current study illuminates how the many aspects of music (i.e. melody, phrasing, rhythm, accompaniment, and meter) can be used in different ways, and how this ultimately affects the perception of novel lexical items in children with ASD. Based on the results, more target lexical items were produced in “The Lake” song than “The Playground” song. It is possible that target lexical items were given greater emphasis in “The Lake” through the use of an eighth-note rest before each lexical item as well as silence in the guitar accompaniment. In addition, the mediant and tonic of the key implemented in “The Lake” song comprised the melodic line corresponding to each of the novel lexical items, which completes the end of the phrase. While the words in “The Playground” song used both repetition in melody and rhythm, the melodic line corresponding to the lexical items was the dominant to mediant, which might not embody the finality of the latter pitch interval. The lexical items of “The Playground” song also did not have the rhythmic emphasis through the use of an eighth-note rest, as the songs were composed for aesthetic quality and the researcher assumed that a rest before a target word would not provide greater emphasis. These differences should be considered and explored further when using music in word learning tasks.

In addition, the present study sought to more efficiently honor the definition of QUIL, thereby producing results that would be more accurate and provide further insight into the proposed differences between sung and spoken stories. Recall that QUIL is a child’s ability to map a novel lexical item to a referent independent of another individual’s influence. In the

Kouri and Winn (2006) study, children were redirected to the story and or song if the participant disengaged and stopped looking at the objects the experimenter presented. In the current study, the researcher did not prompt participants to look at the computer screen when they disengaged, thus, allowing participants to independently make associations between target lexical items and their referents. This coupled with a decrease in exposure to novel lexical items from 10 to 6 could possibly explain the observable gap between the number of lexical items produced in sung vs. spoken scripts despite the small sample size. The largest number of lexical items produced from a single presentation of a spoken script was one word, while two and four words were produced as a result of one presentation of a sung script. These results, while not significant, show that music might be an effective tool to help children in learning novel words. Using music in combination with stories, books, and other visuals could be an effective strategy to use to facilitate speech development, as this might place minimal demands on the child to speak and mimic the child's natural play environment (DeThorne et al., 2009; Hart and Gonzalez, 2009). The findings of the present study warrant further research in using DSLM in the facilitation of QUIL in children with ASD.

Considering sung vs. spoken stories on attention in children with ASD, the results of the current study showed that levels of attention were relatively equal in both conditions. This indicates that both music and verbal instruction are both effective channels for teaching new information. It is also possible that children with ASD respond favorably to video stimuli. Nonetheless, the results of the current study do not provide conclusive evidence of attention differences and should be researched further.

### *Limitations of the Current Study*

It is necessary to discuss the limitations of the current study, including sample size, research design, assessment used for level of functioning, inadequate video media materials used, as well as differences in music compositions, as this will offer further insight into the results. First and foremost, the sample size used in this study is not large enough, and the power of the study is low. The small sample size made it difficult to see any significant variations in production, comprehension, generalization, and attention contingent upon the type of script presented – sung vs. spoken. In short, a larger sample size might have yielded different results.

Second, the research design ultimately had too many variables which could have contributed to each child's production, comprehension, and generalization of novel lexical items. The results showed that there was a significant difference in production from session one to session two, regardless of order. This is possibly due to a learning effect, as both experimental sessions were conducted 24 hours apart. It is possible that if the experimental sessions were conducted further apart from one another, this would stop any learning effects. However, this creates another problem, as many of the children were not able to produce words after only one session. Therefore, the researcher would have to consider increasing the number of times each lexical item was embedded into the story presentation. Another option would be to eliminate the comprehension and generalization portions of the lexical probing. During lexical probing, the examiner asked each child to "Find the (name of target lexical item)" two additional times: once each for comprehension and generalization segments. Regardless, there seems to be a learning effect present from the first to second experimental session.

In addition, the two-period crossover design used in the current study may have also created an order effect, making it even more difficult to pinpoint variables that affected the

results of the current study. It cannot be conclusively stated that the type of presentation affected levels of production, comprehension, generalization, and attention, as the order in which each subject heard the scripts could have also played a role.

Yet another limitation of the current study was the assessment used to determine level of functioning. The CARs score obtained for each participant was used as a covariate for the current study. The CARs assessment was completed by the parents, and therefore, made it difficult for scores to be truly objective and consistent. The subjective nature of the parent/child relationship may have produced inaccurate and highly variable CARs scores for each of the children who participated in the current study. An assessment completed by a trained professional might have been a more valid evaluation of each child's level of functioning.

The electronics used for the current study could have also impacted the results. The researcher played all videos from a personal laptop due to the unfamiliarity of facilities utilized for research. During some of the videos, the sound would become distorted for a couple of seconds, causing incongruence between the audio and video stimuli. Some of the children noticed this, as the subjects would look at the examiner when this occurred. This also impacted the child's eye gaze to the computer monitor. This might have not occurred had the examiner played the DVD from a DVD player instead of a computer screen.

Finally, the differences in music compositions used in the current study could have influenced target lexical items produced, comprehended, and generalized in the sung presentation, as more lexical items were produced in "The Lake" song than "The Playground" song. The eighth-note rest occurring before target items combined with the mediant and tonic scale degrees comprising the melodic motive of target items in "The Lake" song might have put greater emphasis on the target items, creating easier perception and storage in memory. In

summary, sample size, research design, assessment used to determine level of functioning, video media used, and differences in music compositions all contributed to the limitations of the current study.

### *Recommendations for Further Research*

Future replications of the current study have many factors to consider in order to yield better results when examining QUIL in children with ASD. First, replication of the study should include a larger sample size utilizing a Randomized Controlled Trial (RCT) design. Future studies should have three different conditions: a speech group, a music group, and a control group. This would eliminate any carryover or order effects created when utilizing the two-period crossover design implemented in the current study.

If the researcher was able to work collaboratively with other music therapists in order to recruit participants and implement the study, this would be ideal, as the stringent inclusion criteria implemented in the present study made it difficult to recruit a high level of participants. Given video stimuli were recorded and there was a strict protocol in place for lexical probing, it is possible that other therapists could aid in the research process if trained properly and therefore, increase the number of potential research subjects.

Second, future replications should consider experimenting with different levels of frequency – moreover, the number of times novel lexical items are imbedded in the story scripts. The Oetting et al. (1995) study could even be replicated, as this study looked at how children with SLI were able to later recall novel words when compared to typical children when exposed to novel words 0, 1, 3, and 10 times. Video stimuli presenting animated stories were also used in this study, but a replicated study could replace animated spoken stories with songs in which novel words/lexical items are embedded.

Finally, considering the differences in words produced in “The Lake” song vs. “The Playground” song, future research could examine different aspects of music and how changes in meter, rhythm, tempo, accompaniment, and melody might affect the ability of children with ASD to learn novel words in the QUIL context. This might be a tedious process, as there are many possible variations that can be made to one song alone, but at the same time, it could bring music therapists closer to establishing tried and true methods to use when composing songs that foster word learning with efficacy.

### *Conclusion*

The current study illustrates that spoken and sung texts both facilitate QUIL in children with ASD. For the sung presentations, original compositions were created to better parallel the prosody of the spoken scripts. Compositions used emphasized target lexical items through gestalt laws of perception. The scripts used for the current study were very close in comparison to the replicated study and used the same novel lexical items. More words were produced as a result of exposure to sung scripts than spoken scripts; therefore, children with ASD were able to more easily perceive embedded novel lexical items in the sung scripts as compared to spoken scripts. This illustrates that music may be an appropriate medium to use for vocabulary acquisition in children with ASD. The findings also constitute further investigation into the use of DSLM to enhance QUIL in children with autism.



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## APPENDICES

### APPENDIX 1

#### *Novel lexical referents*

- 1) nagoo: (T) white plastic container with green accents used to store bottle nipples with multi-colored spangles glued in various areas across the top. A spoon matching the container was also glued to the front with different colored beads glued on the spoon.
- (G) Same container with blue accents, cotton balls with blue spots glued to top in various places, matching spoon glued to front with another blue cotton ball glued to top of spoon.
- 2) kippee: (T) Two pieces of drain pipe glued to the bottom half of a small box wrapped in blue tissue paper.
- (G) Two pieces of shorter drain pipe glued to the bottom half of a small box wrapped in green tissue paper with multi-colored fuzzy sticks (found in the crafts section in a common general store) protruding out of the top of one pipe opening.
- 3) mabber: (T) Pink rubber spatula with clear plastic handle. Black ribbon with white dots glued on top of handle down center; yellow buttons glued to the top of the spatula around parameter.
- (G) Same spatula, but blue. Green buttons glued to the top of spatula around parameter.

- 4) daynee: (T) Blue, glittery kids hat that is pliable and made of foam (found in the party section at a common general store) glued to a popsicle stick; brown hair net attached to a piece of string and tied to the hat.
- (G) Same as above, except hat used was a pink, glittery crown similar in material and make to the one above.
- 5) paygo: (T) Skewer with red beads on black wire tied to circle end pushed into foam used for artificial flowers; orange fuzzy stick wrapped around the length of the skewer.
- (G) Same concept as above, except three bronze charms were attached to the circle end of a skewer, and a green fuzzy stick was wrapped around the length of the skewer.
- 6) teeky: (T) Orange oil funnel with bottle nipple glued to top.
- (G) Red oil funnel with bottle nipple glued to top; multi-colored glitter poms glued to the top of the nipple.
- 7) widder: (T) Six-inch red, orange, and cream fishing lure pushed into a small box; box is wrapped in blue snowflake gift-wrapping paper. Orange, red, yellow, and blue cable ties stick out from the top of the lure.
- (G) Same lure described above in a small gift-wrapped box, except wrapping paper is gold in color and box is different shape. No cable ties.
- 8) bima: (T) Foam dome used for artificial flowers wrapped in green tissue paper. Five-inch white rope glue to top of dome, hanging loose over the dome.
- (G) Same as above, except dome wrapped in blue tissue paper with neon circle stickers placed sporadically around dome.



## APPENDIX 2

### Story Scripts and Songs

#### The Lake

At the lake we might see a *nagoo*.  
We can ride on a *nagoo*.  
Ride all around,  
All around the lake.  
At the lake we might see a *kippee*.  
We can climb on a *kippee*.  
Climb way up high,  
Only at the lake.  
At the lake we might see a *mabber*.  
We can jump on a *mabber*,  
And ride all around,  
All around the lake.  
At the lake we can use a *daynee*.  
We can catch fish with a *daynee*.  
Catch fish all day long,  
Only at the lake.  
We had so much fun,  
Today, at the lake!

#### The Playground

Time to go to the playground.  
Look! I see a *paygo*.  
We can sit under a *paygo*  
And play for part of the day.  
Having fun at the playground.  
Look! I see a *teeky*.  
We can climb on a *teeky*  
And play for part of the day.  
Having fun at the playground.  
Look! I see a *widder*.  
We can spin 'round on a *widder*  
And play for part of the day.  
Almost time to leave the playground.  
Look! I see a *bima*.  
We can spin 'round on a *bima*  
And play for part of the day.  
We had so much fun,  
Playing the whole day.

# The Lake

Jennifer Cooley

At the lake we might see a na - goo. We can ride on a na - goo.

Ride all a - round, all a - round the lake. At the

lake we might see a kip - pee. We can climb on a Kip - pee.

Climb way up high, on - ly at the lake. At the

lake we might see a mab - ber, We can jump on a mab - ber. And

ride all a - round, all a - round the lake. At the

lake, we can use a day - nee. We can catch fish with a day - nee. Catch

fish all day long only at the lake.

We had so much fun! To - dav. a - t the lake.

# The Playground

Jennifer Cooley

Time to go to the play - ground Look, I see a pay - go.

5 We can sit und - er a pay - go and play for part of the day.

9 Ha - ving fun at the play - ground, Look, I see a

13 tee - ky. We can climb on a tee - ky and play for part of the

17 day. Ha - ving fun at the play - ground.

21 Look, I see a wid - der. We can spin 'round on a wid - der and

25 play for part of the day. Al - most time to lea - ve the

29 play - ground. Look, I see a bi - ma. We can spin 'round on a

33 bi - ma and play for part of the day.

37 We had so much fun

41 play - ing the who - o - le day!

## APPENDIX 3

### Informed Consent

#### **Consent to Participate in a Research Study Colorado State University**

**TITLE OF STUDY:** The use of Developmental Speech and Language Training through Music on Quick Incidental Learning in Children with Autism Spectrum Disorders

**PRINCIPAL INVESTIGATOR:** Blythe Lagasse, Music, Theatre, and Dance, Ph.D., Email: [Blythe.Lagasse@colostate.edu](mailto:Blythe.Lagasse@colostate.edu), Phone: (970) 491-4042

**CO-PRINCIPAL INVESTIGATOR:** Jennifer Cooley, Music, Theatre, and Dance, graduate student, Email: [jennlc\\_84@hotmail.com](mailto:jennlc_84@hotmail.com), Phone: 573-772-0585

**WHY AM I BEING INVITED TO TAKE PART IN THIS RESEARCH?** Your child is being asked to participate in the study because he or she has a diagnosis of autism. Children with autism have difficulty communicating and socializing with others, and it is necessary to show evidence of treatments that might help children with autism to learn speech, communication, and socialization skills more effectively. The current study will examine whether a music therapy technique is effective in helping children to learn new words in a short amount of time.

**WHO IS DOING THE STUDY?** The research will be conducted by Jennifer Cooley, a board-certified music therapist with additional Neurologic Music Therapy training. This researcher is also a graduate student at Colorado State University. The researcher will also have assistance from Dr. Blythe Lagasse, who is a professor of music therapy at Colorado State University. Other people assisting the researcher will include music therapists at TouchPoint Autism Services, which is the employer of the researcher.

**WHAT IS THE PURPOSE OF THIS STUDY?** The researcher hopes to discover if children learn words at an increased rate and show greater levels of attention as a result of a specific music therapy technique rather than spoken stories.

**WHERE IS THE STUDY GOING TO TAKE PLACE AND HOW LONG WILL IT LAST?** The study will take place at TouchPoint Autism Services in Cape Girardeau, MO, as well as the satellite TouchPoint office in Poplar Bluff, MO. Your child will be asked to participate in three total sessions, each of which will last 30-60 minutes. These sessions must be at least 24 hours apart, and all three sessions must be completed in 3-5 days.

**WHAT WILL I BE ASKED TO DO?** Your child will be asked to participate in a total of three sessions: one assessment and two experimental sessions.

- **Session 1:** Your child will undergo an assessment, in which the researcher will collect information that shows your child has a diagnosis of autism and will obtain your child's

overall speech pattern. Moreover, the researcher will show the client 8 objects that are unfamiliar to the child while saying the corresponding name of each object, and will have your child imitate the researcher by saying the name of the object. Your child will be tested on these 8 words after each experimental session. **The researcher will record this portion of the assessment**, as the researcher is not a speech pathologist and cannot accurately identify the child's speech pattern. This portion of the research will be watched by a recruited speech pathologist. It should be noted that the speech pathologist will not know the name of your child, as the researcher will use a coded list that helps only the researcher identify your child by name.

- **Session 2:** This will be the first experimental session, which will take place the next day. Your child will be randomly placed, much like the roll of the dice, in one of two groups. He/she will be tested individually. Your child will watch a video presentation that includes two different videos: one video will include a sung script, while the other will include a spoken script. Your child's placement in a group will predict the order in which your child hears these scripts. For example, your child might hear "Song script A" followed by "Spoken script B" for the first experimental session. The session will take approximately 30 minutes.
- **Session 3:** This experimental session will be very much like session 2, except your child will hear the opposite presentation of the scripts (i.e. first, your child will hear "Song Script B" followed by "Spoken Script A"). Once again, your child will be tested individually, and the session should take approximately 30 minutes.

**Both experimental sessions will be recorded.** These sessions will be recorded because the researcher will also examine how well your child attends to both of these script presentations by recording eye gaze toward the TV monitor. The researcher will train one other person in data coding to determine your child's overall attention to each of the two scripts. Therefore, a video camera will be mounted on top of the TV monitor. Therefore, there will be a total of three sessions: a pre-test, and two experimental sessions. Each of these three sessions will be spanned over three days.

Food (e.g. crackers), stickers, and prizes (a small toy for \$1 or less) will be used to increase your child's participation throughout both videos. If your child cannot have the food provided due to dietary restraints, stickers will be used. The researcher will give your child food or stickers after each video to reward your child for good behavior (i.e. remaining in chair, attending to video, etc.) However, your child will not be penalized for withdrawing early from the experimental session and will still receive food or stickers before leaving, regardless of the length of his or her participation. If your child earns food after each video, then he/she will receive a prize to keep after the post-test.

After each experimental session, your child will be given a five minute break, and then the researcher will administer a post-test, examining the child's learning of each word presented. The researcher will examine how well your child can *produce* the new word when shown the corresponding object, if your child can *find the object* matching the new word when presented with multiple objects, and if your child can *find a similar object* to the corresponding object matching the new word. **The post-test portions of the experiment will be recorded.** The same

recruited speech pathologist will watch the post-test to determine if your child is saying the word correctly based on his or her speech pattern. This portion should take a maximum of 15 minutes.

**ARE THERE REASONS WHY I SHOULD NOT TAKE PART IN THIS STUDY?** Given your child has a diagnosis of autism, your child might experience stress as a result of being in a new environment, around new people, etc. If your child does show signs of distress (e.g., crying, refusal to watch the video, shouting), the researcher will immediately stop the experiment and your child will be free to leave.

**WHAT ARE THE POSSIBLE RISKS AND DISCOMFORTS?**

There are no foreseeable risks or discomforts for your child by participating in this study. It is not possible to identify all potential risks in research procedures, but the researcher(s) have taken reasonable safeguards to minimize any known and potential, but unknown, risks.

**ARE THERE ANY BENEFITS FROM TAKING PART IN THIS STUDY?** There are no benefits for your child's participation in this study. However, the findings from the study could provide further evidence for music therapy as a treatment method for speech and language development.

**DO I HAVE TO TAKE PART IN THE STUDY?** Your child's participation in this research is voluntary. If you and your child decide to participate in the study, he/she may withdraw his/her consent and stop participating at any time without penalty or loss of benefits to which he/she is otherwise entitled.

**WHAT WILL IT COST ME TO PARTICIPATE?** The only foreseeable cost would be travel expenses due to driving to and from one of the TouchPoint Autism Services sites.

**WHO WILL SEE THE INFORMATION THAT I GIVE?** We will make every effort to prevent anyone who is not on the research team from knowing that you gave us information, or what that information is. For example, your name will be kept separate from your research records and these two things will be stored in different places under lock and key. A coded list will be used when recording and sharing data with others on the research team, so only the researcher will have access to your identity.

Your information will be combined with information from other people taking part in the study. When we write about the study to share it with other researchers, we will write about the combined information we have gathered. You will not be identified in these written materials. We may publish the results of this study; however, we will keep your name and other identifying information private.

You should know, however, that there are some circumstances in which we may have to show your information to other people. For example, the law may require us to show your information to a court OR to tell authorities if we believe you have abused a child, or you pose a danger to yourself or someone else.

**CAN MY TAKING PART IN THE STUDY END EARLY?** The only reason that your child's participation in the study would end early is if your child fails to complete all sessions in the given amount of time, which is 3-5 days.

**WILL I RECEIVE ANY COMPENSATION FOR TAKING PART IN THIS STUDY?** Your child will receive food or stickers and a small gift of \$1 or less.

**WHAT IF I HAVE QUESTIONS?**

Before you decide whether to accept this invitation to take part in the study, please ask any questions that might come to mind now. Later, if you have questions about the study, you can contact the investigator, Jennifer Cooley, MT-BC at 573-772-0585. If you have any questions about your rights as a volunteer in this research, contact Janell Barker, Human Research Administrator at 970-491-1655. We will give you a copy of this consent form to take with you.

This consent form was approved by the CSU Institutional Review Board for the protection of human subjects in research on 9/12/2011.

**WHAT ELSE DO I NEED TO KNOW?** Your signed consent forms give permission to the researcher, Jennifer Cooley, (1) to access information regarding your child's score on autism rating scale and (2) allow a recruited speech pathologist and another assistant from the Co-Principal's place of work to watch videos of your child in order to assess speech pattern and attention. Only the researcher will have access to your child's name, as the researcher will use a coded list to label all videos and documents relating to the study.

Your signature acknowledges that you have read the information stated and willingly sign this consent form. Your signature also acknowledges that you have received, on the date signed, a copy of this document containing 4 pages.

### PARENTAL SIGNATURE FOR MINOR

As parent or guardian I authorize \_\_\_\_\_ (print name) to become a participant for the described research. The nature and general purpose of the project have been satisfactorily explained to me by \_\_\_\_\_ and I am satisfied that proper precautions will be observed.

\_\_\_\_\_  
Minor's date of birth

\_\_\_\_\_  
Parent/Guardian name (printed)

\_\_\_\_\_  
Parent/Guardian signature

\_\_\_\_\_  
Date

\_\_\_\_\_  
Signature of Research Staff